

## CLAIMS

We claim:

- 1 1. A method of fabricating a layer of material in an integrated circuit (IC), the layer  
2 including a pattern, the layer defined by a layout data, the method comprising:  
3       analyzing the layout data to determine whether substantial portions of the pattern are to  
4 be defined using a phase shifting pattern; and  
5       responsive to the analyzing, configuring an optical lithography exposure system to have a  
6 setting of a set of one or more optical parameters that control characteristics of exposures, to  
7 expose at least a first mask pattern and a second mask pattern for use in defining the layer of  
8 material to use said setting for exposing each mask pattern, and wherein the first mask pattern  
9 comprises an alternating aperture phase shifting pattern and wherein the second mask pattern  
10 comprises a trim pattern.
- 1 2. The method of claim 1, wherein the analyzing comprises determining if all of the pattern  
2 on the layer is defined using phase shifting.
- 1 3. The method of claim 1, wherein the layout data comprises a "full phase" design such that  
2 the first mask pattern comprises a "full phase" mask pattern.
- 1 4. The method of claim 1, wherein the analyzing comprises determining if one or more of  
2 all of the pattern is defined using phase shifting, wherein a pattern is exposed on the layer which  
3 can be characterized by one or more of the following: at least eighty percent (80%) of the non-  
4 memory portions of the pattern are defined by the phase shift pattern; at least eighty percent  
5 (80%) of a part of the floorplan in the pattern is defined by the phase shift pattern; at least ninety  
6 percent (90%) of the pattern is defined by the phase shift pattern; all of the features in the critical  
7 path of the pattern are defined by the phase shift pattern; all features in the pattern except those  
8 features that are not phase shifted due to phase conflicts are defined by the phase shift pattern;  
9 everything in the pattern except test structures are defined by the phase shift pattern; and  
10 everything in the pattern except dummy structures are defined by the phase shift pattern.

- 1    5.    The method of claim 1, wherein a pattern is exposed on the layer which can be  
2    characterized by having at least ninety-five (95%) of the pattern defined by the phase shift  
3    pattern.
- 1    6.    The method of claim 1, wherein the optical lithography exposure system comprises at  
2    least one of a stepper and a scanner.
- 1    7.    The method of claim 1, wherein the first mask pattern and the second mask pattern are on  
2    a single reticle.
- 1    8.    The method of claim 1, wherein said set of optical parameters consists of the numerical  
2    aperture (N.A.), wavelength ( $\lambda$ ) of radiation, partial coherency ( $\sigma$ ), illumination configuration,  
3    and defocus.
- 1    9.    The method of claim 1, wherein said set of optical parameters comprise one or more of  
2    the numerical aperture (N.A.), wavelength ( $\lambda$ ) of radiation, partial coherency ( $\sigma$ ), illumination  
3    configuration, and defocus.
- 1    10.   The method of claim 1, further comprising exposing the layer of material in the optical  
2    lithography exposure system using a first dosing for the first mask pattern and a second dosing  
3    for the second mask pattern, the first dosing and the second dosing in a ratio of 1.0 to  $r$ ,  $r > 0.0$ .
- 1    11.   The method of claim 10, wherein  $2.0 \leq r \leq 4.0$ .
- 1    12.   The method of claim 10, wherein the first mask pattern and the second mask pattern are  
2    on a single reticle.
- 1    13.   The method of claim 12, wherein the exposing further comprises blading the first mask  
2    pattern and second mask pattern during the exposing to permit different dosing.

1    14. The method of claim 12, and wherein the single reticle further includes a second instance  
2    of the second mask pattern and wherein the exposing comprises exposing the layer of material to  
3    the single reticle in a pattern to cause a 1:2 exposure ratio between the first mask pattern and  
4    instances of the second mask patterns.

1    15. A reticle for use in defining a pattern in a layer of material of an integrated circuit (IC)  
2    production using optical lithography in an optical lithography exposure system having a set of  
3    one or more optical parameters that control characteristics of exposures, the reticle for defining a  
4    layer of material in an IC, the reticle comprising at least two patterns:

5         a first pattern comprising a phase shifting mask; and

6         a second pattern comprising a trim mask,

7                 the first pattern defining a sufficient amount of the layer of material using phase shifting  
8                 to allow the use of substantially the same settings of said set of one or more optical parameters  
9                 for both the first pattern and the second pattern.

10      16. The reticle of claim 15, wherein a pattern is exposed on the layer which can be  
11      characterized by one or more of the following: at least eighty percent (80%) of the non-memory  
12      portions of the pattern are defined by the phase shift pattern; at least eighty percent (80%) of a  
13      part of the floorplan in the pattern is defined by the phase shift pattern; at least ninety percent  
14      (90%) of the pattern is defined by the phase shift pattern; all of the features in the critical path of  
15      the pattern are defined by the phase shift pattern; all features in the pattern except those features  
16      that are not phase shifted due to phase conflicts are defined by the phase shift pattern; everything  
17      in the pattern except test structures are defined by the phase shift pattern; and everything in the  
18      pattern except dummy structures are defined by the phase shift pattern.

19      17. The reticle of claim 15, wherein a pattern is exposed on the layer which can be  
20      characterized by having at least ninety-five (95%) of the pattern defined by the phase shift  
21      pattern.

1    18. The reticle of claim 15, wherein said set of optical parameters consists of the numerical  
2    aperture (N.A.), wavelength ( $\lambda$ ) of radiation, partial coherency ( $\sigma$ ), illumination configuration,  
3    and defocus.

1    19. The reticle of claim 1, wherein said set of optical parameters comprise one or more of the  
2    numerical aperture (N.A.), wavelength ( $\lambda$ ) of radiation, partial coherency ( $\sigma$ ), illumination  
3    configuration, and defocus.

1    20. The method of claim 15, wherein substantially the same comprises within plus or minus  
2    10%.

1    21. The reticle of claim 15, wherein the reticle further includes a third pattern substantially  
2    identical to the second pattern, such that the layer defined by a triple exposure comprising one  
3    exposure by the first pattern, one exposure by the second pattern, and a third exposure by the  
4    third pattern.

1    22. The reticle of claim 15, wherein the reticle further includes a third pattern comprising a  
2    phase shifting pattern, and wherein the first pattern for defining features oriented in a first  
3    direction in the pattern and the third pattern for defining oriented in a second direction features in  
4    the pattern, such that the layer defined by a triple exposure comprising one exposure by the first  
5    pattern, one exposure by the second pattern, and a third exposure by the third pattern.

1    23. An method of manufacturing an integrated circuit (IC) product comprising:  
2         defining at least one layer of material in the IC using at least two mask patterns, the layer  
3         of material comprising a pattern, the first mask pattern comprising a phase shifting pattern and  
4         the second mask pattern comprising a trim pattern, the first pattern defining substantially all of  
5         the pattern of the layer of material and the second pattern for protecting the pattern and clearing  
6         phase shifting artifacts;  
7         exposing layer of material in an optical lithography exposure system having a setting of a  
8         set of one or more optical parameters that control characteristics of exposures, to the first mask

9 pattern and the second mask pattern, where said setting is substantially the same while exposing  
10 the first and second mask patterns.

1 24. The method of manufacturing an IC product of claim 23, wherein the first mask pattern  
2 comprises a “full phase” mask.

3 The method of manufacturing an IC product of claim 0, wherein the pattern on the layer  
4 of material can be characterized by one or more of the following: at least eighty percent (80%) of  
5 the non-memory portions of the pattern are defined by the phase shift pattern; at least eighty  
6 percent (80%) of a part of the floorplan in the pattern is defined by the phase shift pattern; at  
7 least ninety percent (90%) of the pattern is defined by the phase shift pattern; all of the features  
8 in the critical path of the pattern are defined by the phase shift pattern; all features in the pattern  
9 except those features that are not phase shifted due to phase conflicts are defined by the phase  
10 shift pattern; everything in the pattern except test structures are defined by the phase shift  
11 pattern; and everything in the pattern except dummy structures are defined by the phase shift  
12 pattern.

1 25. The method of manufacturing an IC product of claim 23, wherein the pattern on the layer  
2 of material can be characterized by having at least ninety-five (95%) of the pattern defined by the  
3 phase shift pattern.

1 26. The method of manufacturing an IC product of claim 23, wherein the optical lithography  
2 exposure system comprises at least one of a stepper and a scanner.

1 27. The method of manufacturing an IC product of claim 23, wherein the first mask pattern  
2 and the second mask pattern are on a single reticle.

1 28. The method of manufacturing an IC product of claim 23, wherein said set of optical  
2 parameters consists of the numerical aperture (N.A.), wavelength ( $\lambda$ ) of radiation, partial  
3 coherency ( $\sigma$ ), illumination configuration, and defocus.

- 1       29.     The method of manufacturing an IC product of claim 23, wherein said set of optical  
2     parameters comprise one or more of the numerical aperture (N.A.), wavelength ( $\lambda$ ) of radiation,  
3     partial coherency ( $\sigma$ ), illumination configuration, and defocus.
- 1       30.     The method of manufacturing an IC product of manufacturing an IC product of claim 23,  
2     wherein substantially the same comprises within plus or minus 10%.
- 1       31.     The method of manufacturing an IC product of claim 23, wherein the exposing further  
2     comprises using a first dosing for the first mask pattern and a second dosing for the second mask  
3     pattern, the first dosing and the second dosing in a ratio of 1.0 to  $r$ ,  $r > 0.0$ .
- 1       32.     The method of manufacturing an IC product of claim 31, wherein  $2.0 \leq r \leq 4.0$ .
- 1       33.     The method of manufacturing an IC product of claim 23, wherein the first mask pattern  
2     and the second mask pattern are on a single reticle.
- 1       34.     The method of manufacturing an IC product of claim 33, and wherein the exposing  
2     further comprises blading the first mask pattern and second mask pattern on the reticle during the  
3     exposing to permit different dosing.
- 1       35.     The method of manufacturing an IC product of claim 33, and wherein the single reticle  
2     further includes a second instance of the second mask pattern and wherein the exposing  
3     comprises exposing the layer of material to the instances of the mask patterns on the single  
4     reticle in a sequence to cause a 1:2 exposure ratio between the first mask patterns and instances  
5     of the second mask pattern.
- 1       36.     A method for manufacturing an integrated circuit, comprising:  
2              forming a layer of resist on a wafer;  
3              exposing the layer to a first dose of radiation through a phase shifting pattern in a mask,  
4     the radiation characterized by set of one or more parameters selected for exposure of the phase  
5     shifting pattern; and

6               exposing the layer to a second dose of radiation through a trim pattern in a mask, the  
7   radiation characterized by said set of parameters.

1   37.   The method of claim 36, wherein said set of parameters includes a parameter indicating  
2   partial coherence  $\sigma$  of the radiation at the layer.

1   38.   The method of claim 36, wherein said set of parameters includes a parameter indicating  
2   the numerical aperture NA of the radiation at the layer.

1   39.   The method of claim 36, wherein said set of parameters includes a parameter  
2   indicating an axis of propagation of the radiation at the layer.

1   40.   The method of claim 36, wherein said set of parameters includes a parameter indicating  
2   an illumination configuration of the radiation.

1   41.   The method of claim 36, wherein said set of parameters includes a parameter indicating  
2   defocus of the radiation at the layer.

1   42.   The method of claim 36, wherein said set of parameters includes parameters indicating  
2   numerical aperture NA of the radiation at the layer, partial coherence  $\sigma$  of the radiation at the  
3   layer, an axis of propagation of the radiation at the layer, an illumination configuration of the  
4   radiation, and defocus of the radiation at the layer.

1   43.   The method of claim 36, wherein said first dose and said second dose are different.

1   44.   The method of claim 36, wherein said phase shift pattern and said trim pattern are on a  
2   single mask.

1   45.   The method of claim 36, wherein a pattern is exposed on the layer which can be  
2   characterized by one or more of the following: at least eighty percent (80%) of the non-memory  
3   portions of the pattern are defined by the phase shift pattern; at least eighty percent (80%) of a

4 part of the floorplan in the pattern is defined by the phase shift pattern; at least ninety percent  
5 (90%) of the pattern is defined by the phase shift pattern; all of the features in the critical path of  
6 the pattern are defined by the phase shift pattern; all features in the pattern except those features  
7 that are not phase shifted due to phase conflicts are defined by the phase shift pattern; everything  
8 in the pattern except test structures are defined by the phase shift pattern; and everything in the  
9 pattern except dummy structures are defined by the phase shift pattern.

1 46. The method of claim 36, wherein a pattern is exposed on the layer which can be  
2 characterized by having at least ninety-five (95%) of the pattern defined by the phase shift  
3 pattern.

91 47. The method of claim 36, wherein said set of parameters comprises parameters that are  
92 changed by a mechanical adjustment of an optical element.

93 48. A method for manufacturing an integrated circuit, comprising:  
94 forming a layer of resist on a wafer in a first process station;  
95 moving the wafer to a second process station including a radiation source, a mask and an  
optical path for exposing the wafer to radiation, the optical path being characterized by a set of  
optical parameters including one or more of a wavelength  $\lambda$  of illumination, numerical aperture  
NA, coherence, illumination configuration, and defocus;  
96 exposing, in the second process station, the layer to a first dose of radiation through a  
phase shifting pattern in said mask using a first setting of set of optical parameters; and  
97 exposing, in the second process station, the layer to a second dose of radiation through a  
trim pattern in said mask using said first setting.

1 49. The method of claim 48, wherein said set of optical parameters includes the numerical  
2 aperture and partial coherence  $\sigma$ .

1 50. The method of claim 48, wherein said set of optical parameters includes the numerical  
2 aperture NA, partial coherence  $\sigma$ , the illumination configuration, and the defocus.

1    51.    The method of claim 48, wherein said set of optical parameters includes partial coherence  
2     $\sigma$  as the coherence parameter.

1    52.    The method of claim 48, wherein said first dose and said second dose have different  
2    dosage levels.

1    53.    The method of claim 48, wherein a pattern is exposed on the layer which can be  
2    characterized by one or more of the following: at least eighty percent (80%) of the non-memory  
3    portions of the pattern are defined by the phase shift pattern; at least eighty percent (80%) of a  
4    part of the floorplan in the pattern is defined by the phase shift pattern; at least ninety percent  
5    (90%) of the pattern is defined by the phase shift pattern; all of the features in the critical path of  
6    the pattern are defined by the phase shift pattern; all features in the pattern except those features  
7    that are not phase shifted due to phase conflicts are defined by the phase shift pattern; everything  
8    in the pattern except test structures are defined by the phase shift pattern; and everything in the  
9    pattern except dummy structures are defined by the phase shift pattern.  
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1    54.    The method of claim 48, wherein a pattern is exposed on the layer which can be  
2    characterized by having at least ninety-five (95%) of the pattern defined by the phase shift  
3    pattern.

1    55.    The method of claim 48, wherein said set of parameters comprises parameters that are  
2    changed by a mechanical adjustment of an optical element.